

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR LETTERS PATENT

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10 INVENTION : EDI DEVICE WITH COMPOSITE
ELECTRODE

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15 TO ALL WHOM IT MAY CONCERN:

Be it known that I/We, the above-identified applicant(s), have made a certain new and useful invention in EDI DEVICE WITH COMPOSITE ELECTRODE of which the following is a specification.

TITLE OF THE INVENTION:
EDI DEVICE WITH COMPOSITE ELECTRODE

FIELD OF THE INVENTION:

5 This invention relates to an electrodeionization (EDI) water producing device. In particular, this invention relates to electrodes used in an EDI module and to improvements in the electrode structure.

BACKGROUND OF THE INVENTION

10 Water treatment equipment is broadly used in many industry fields. Traditional water treatment processes treat water by desalting source water. Typically, desalinated equipment combines ion-exchange technology and electrodialysis technology. For example, Chinese Patent No. 96244875.4 shows an EDI device which combines ion-exchange technology and electrodialysis technology. In Chinese Patent No. 96244875.4, anion and cation resin is placed inside a dilute water chamber of the electrodialysis device and positive and negative electrodes are placed outside the device.

15 The advantages of this approach are that the same distance is achieved between every two arrays of membranes, the EDI device has a reliable and stable resistance, and the current intensity is relatively easy to control. The disadvantage of this approach is that it is difficult to fill the device with resins; special ion fiber knitting is necessary. To resolve this issue, an improved EDI module uses a spiral wound cylinder structure.

20 Chinese Patent No. 00220610.2 shows a multi-surface volume EDI module which consists of positive and negative electrodes, membrane bags and a frame. The anion and cation ion exchange membranes are combined with isolation net sheets to form membrane bags which fold to include concentrate water channels and dilute water channels. Each of the concentrate water channels and the dilute water channels connects to a different individual water collection 25 chamber extending from a dilute/concentrate collection pipe. The dilute water channels are filled with ion-exchange resins, and consist of linked together rectangular channels.

30 It is known that the anode is set on the shell of this kind of EDI, while the cathode is placed within the shell. In other words, while the cathode is located within the EDI device, the anode is manufactured separate from the EDI device vessel and is attached to the outside of the device.

5 U.S. Patent No. 6,190,528, issued February 20, 2001 to Xiang Li et al. discloses a helical EDI apparatus having the disadvantages described above. The anode 10 of the EDI device disclosed in U.S. Patent No. 6,180,528 is also manufactured separately and subsequently attached to the outside of the EDI device. U.S. Patent No. 6,190,528 is incorporated herein by reference in its entirety.

SUMMARY OF THE INVENTION

10 In accordance with a preferred embodiment, an electrodeionization (EDI) device includes a shell surrounding an inner module, an electrode enclosed within the inner wall of the shell, and an electrical contact plate attached along the inner wall of the shell. The electrical contact plate is conductively connected to the electrode within the shell to transfer current to the electrode. This embodiment may also include a first vessel cover connected to the shell at its first end, and an electrical contact member attached to the first vessel cover. The electrical contact member is arranged to conductively connect to the electrical contact plate to transfer current to the electrical contact plate.

15 In another preferred embodiment, an electrodeionization (EDI) device includes an anion exchange membrane, a cation exchange membrane, a first electrode, at least one membrane bag formed by the anion exchange membrane and the cation exchange membrane, and a second electrode. The membrane bag also includes a concentrate flow channel. A dilute water flow channel is located adjacent to the at least one membrane bag. The at least one membrane bag and the dilute flow channel forms an inner module. The EDI device also includes a shell surrounding the inner module, and an electrical contact plate attached along the inner wall of the shell. The second electrode is enclosed within the inner wall of the shell. The electrical contact plate is conductively connected to the second electrode within the shell to transfer current to the second electrode.

20 25 Further scope of applicability of the present invention will become apparent from the description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since the invention will become apparent to those skilled in the art from this detailed description.

The invention will be described in conjunction with the following drawings in which like referenced numerals designate like elements and wherein:

Fig. 1 is a sectional view of an EDI vessel (module) cover in accordance with a preferred embodiment of the invention;

5 Fig. 2 is a sectional view of the frame of the EDI module in accordance with the preferred embodiments; and

Fig. 3 is a top view of the EDI module along line 3-3 of Fig. 2.

DETAILED DESCRIPTION OF THE INVENTION

This invention resolves problems of the complex manufacture for EDI device electrodes, 10 namely weak intensity and unreliable electrical contact. In a preferred embodiment, a spiral wound EDI device vessel includes a composite electrode wrapped within the EDI vessel cylinder shell. The cylinder shell and composite electrode are arranged to fit around a spiral wound EDI inner module. An exemplary inner module includes a concentrate center axial conduit or pipe that is also an electrode axially positioned along the center axis of the EDI 15 device. The exemplary EDI inner module also includes anion and cation ion exchange membranes connected and wound about the axial conduit to form concentrate/dilute water chambers. Either the anode or cathode can be placed or attached to the axial conduit. The other electrode can be set in the vessel lining of the shell as an electrode plate. Preferably, the electrode plate is positioned within adjacent inwardly extending shoulders of the vessel lining 20 of the EDI device cylinder shell. The shoulders also abut the top and bottom covers when the EDI module is fully assembled. When assembled, the top and bottom covers are attached to the shell to form a housing.

An electrical contact plate electrically communicates with the electrode plate. The 25 electrode contact plate and electrode plate are preferably formed of titanium or stainless steel. An electrical contact reed attached to one of the vessel covers electrically communicates with the electrical contact plate when the vessel cover is attached to the cylinder shell. The contact reed is preferably integrated with the cover.

30 Preferably, the surface of the electrode plate is coated with a platinum or a silver-ruthenium alloy layer to improve the electrical permeate. Alternatively, the preferred electrode is made of alloy. While not critical to the invention, the electrode plate is preferably the anode.

The electrical contact reed is preferably connected to the DC in the cover of the EDI device. The electrode plate is integrated within the vessel to simplify the EDI module structure and improve the reliability of the electrical contact.

The invention can best be seen, by example, in Figs. 1-3. Fig. 1 shows a vessel cover 12 adapted to be frictionally coupled to an EDI cylindrical shell 14. The vessel cover 12 includes an electrical contact reed 16 arranged for electrical contact with an electrical contact plate 18 attached within an inner wall 20 of the cylindrical shell 14. As can best be seen in Figs. 2 and 3, the cylindrical shell 14 also encloses an electrode plate 22, which is preferably an anode, within the inner wall 20. The shell 14 also includes two shoulders 24, 26 extending inwardly from the inner wall 20. The shoulders 24, 26 abut the edges of the electrode plate 22 and keep the plate from sliding longitudinally within the cylindrical shell 14. The electrode plate 22 contacts the electrical contact plate 18. The vessel covers 12 are attached to the cylindrical shell 14 to form an EDI housing. When the EDI housing is assembled, the electrical contact plate 18 electrically communicates with both the electrical contact reed 16 and the electrode plate 22, and thus becomes a conductive bridge therebetween. The electrical contact reed 16 is electrically coupled to DC outside the shell 14, and thus the contact reed and electrical contact plate provide reliable DC contact to the electrode plate 22.

The cylindrical shell 14 is preferably made of FPR or plastic. The electrode plate 22 is preferably made of stainless steel or titanium alloy coated with platinum layer or silver-ruthenium alloy layer. Alternatively, the electrode plate 22 is made of an alloy material. As described above, the EDI inner module has a concentrate center pipe as the electrode along the center axis of the EDI module, with at least one layer of anion/cation exchange membranes and a support frame in concentrate/dilute chambers wound around the center pipe. The electrode plate is integrated with the vessel to simplify the whole structure and improve the reliability of the electrical contact.

The support frame is described in combination with an EDI device that is spiral wound or helical. It is understood that the support frame can also be used with other types of EDI devices, including stacked EDI devices. Accordingly, the scope of the invention is not limited to spiral wound EDI devices, but includes various other types of EDI devices, as readily understood by a skilled artisan.

It should be apparent from the aforementioned description and attached drawings that the concept of the present invention may be readily applied to a variety of preferred embodiments, including those disclosed herein. For example, as previously noted, while the

support frame is described in accordance with a preferred embodiment for a helical EDI device, it is understood that the frame is applicable to other types of EDI devices, including stacked EDI devices, in accordance with other preferred embodiments. Without further elaboration, the foregoing will so fully illustrate the invention that others may, by applying current or future knowledge, readily adapt the same for use under various conditions of service.

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